

NO. 4. — *Reports on the Results of Dredging under the Supervision of ALEXANDER AGASSIZ, in the Gulf of Mexico (1877-78), and in the Caribbean Sea (1878-79), by the U. S. Coast Survey Steamer "Blake," LIEUT.-COMMANDER C. D. SIGSBEE, U. S. N., and COMMANDER J. R. BARTLETT, U. S. N., Commanding.*

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### XVIII.

*The Stalked Crinoids of the Caribbean Sea.* By P. HERBERT CARPENTER.

OWING to the lamented death of the late Sir Wyville Thomson, it has become my duty to complete the Report upon the Stalked Crinoids of the "Challenger" Expedition, which had been commenced by him. It had been arranged between Sir Wyville and Mr. Agassiz that the descriptions of the species obtained by the "Blake" in the Caribbean Sea should be incorporated in the "Challenger" report, which would thus assume the character of a Monograph of nearly all the known species of the group.\* For this purpose nearly thirty plates were drawn at Edinburgh, under Sir Wyville's superintendence, but, except for a few pencil notes upon one or two of them, he has unfortunately left no manuscript behind him of any kind. It has therefore become my duty to make good this deficiency; but as the other calls upon my time leave me only a limited amount of leisure, I fear that some months must yet elapse before the publication of the final report.

The "Blake" dredgings have shown that the bathymetrical range of the Stalked Crinoids is not always so great as has been often supposed. So far as my information goes, they have only been obtained fourteen times at depths exceeding 650 fathoms, their lowest limit being the celebrated deep dredging of the "Porcupine," in 1869, where *Bathyrinus*

\* *Ithyris carpenteri* of the Norwegian North Atlantic Expedition (Nyt Mag. for Naturvid., Bd. XXIII., 1877) is undoubtedly a *Bathyrinus*, though I do not think it is identical with *B. gracilis* of the first "Porcupine" Expedition (1869). The "Vega" dredged some Stalked Crinoids off the Siberian coast, and also a large *Metacrinus* in the North Pacific, but no descriptions of them have yet been published.

*gracilis* was obtained in 2435 fathoms. A young *Hyocrinus* (?) was dredged by the "Challenger" in 2325 fathoms, while *Antedon* was found at 2600 and at 2900 fathoms.

So far as I am aware, no entire *Pentacrinus* was obtained by the "Blake" at a greater depth than 250 fathoms,\* while six of the "Challenger" species were found within that limit; though the "Porcupine" dredged *P. wyville-thomsoni* in 1095 fathoms in 1870, and the "Challenger" got a fragment of *P. naresianus* Wy. Th. MS., in the Pacific, at 1350 fathoms, this being the deepest *Pentacrinus* yet known. *Bathycrinus*, however, ranges from 1050 to 2435 fathoms, and *Hyocrinus* from 1600 to 2325 fathoms, while *Rhizocrinus lofotensis* occurs in the Norwegian fiords at 80 fathoms, and in 175 to 955 fathoms in the Caribbean Sea. It is a great pity that we have no later knowledge of the "Austrian Encrinite" on a stem 6" long, which was obtained by Poore † at a depth of 8 fathoms in King George's Sound.

It is well known that three genera of Stalked Crinoids occur in the Caribbean Sea besides the three *Comatula* ‡; viz. *Pentacrinus*, *Holopus*, and *Rhizocrinus*. The last-named is represented by two species, and the first by four, viz. *P. asteria* Linn. sp., *P. mülleri* Oerst., *P. decorus* Wy. Th., and *P. blakei* n. sp. The first of these, which is the type species of the genus, seems never to have been dredged by the "Blake," except perhaps in a fragmentary state. It is mentioned, however, by Mr. Agassiz § as having been dredged off Havana in 1878, but the individuals there referred to really belong to *P. mülleri*; while the very variable form with a slender stem, which Mr. Agassiz and the late Mr. Pourtalès have spoken of as *P. mülleri*, is really the *P. decorus* of Sir Wyville Thomson. These two species have hitherto been confused with one another, and it is only since I have been able to examine the original types of them in the Copenhagen and British Museums respectively, that I have succeeded in forming clear ideas about them. The relations of the Caribbean species to one another, and to the other species of the genus, are shown in the following scheme.

\* Specimens were obtained in as little as 42 fathoms, and stem fragments down to 470 fathoms.

† Ann. and Mag. Nat. Hist. (1862), Vol. IX. p. 486.

‡ *Antedon*, *Actinometra*, and *Atelecrinus*. See Bull. Mus. Comp. Zool., Vol. IX. No. 4.

§ Bull. Mus. Comp. Zool., Vol. V. No. 6, p. 56.

Genus PENTACRINUS MILLER.

The two outer radials and the first two joints beyond each axillary united by syzygies.	Five cirri at each node.	Cirri large and stout, of 35-43 joints. Rays may divide five times.	15-25 cirrus-joints. Rays only divide three times; each division of two joints united by syzygy.	Usually 15-18 internodal joints. The hypozygal does not share in the cirrus-sockets. Usually more than three joints between the irregular arm divisions. Pinnule joints have forward-projecting processes.	} <i>asteria</i> Linn.
				6-8 internodal joints. The hypozygal shares in the cirrus-sockets. Only two or three joints between the regular arm divisions.	
The two outer radials and the first two joints beyond them united by ligamentous articulations.	Two and three cirri alternately at successive nodes. Rays divide three times; each division of two joints united by syzygy. Four internodal joints.	Ten arms. The third brachial a syzygy, with angular syzygial faces. First pinnule on the second brachial. 8-17 internodal joints.	11 or 12 internodal joints. Nodal joints enlarged and projecting, and the hypozygal grooved to receive the cirrus-bases. Syzygial faces nearly plane.	One or two internodal joints . . . . .	} <i>maclearanus</i> Wy. Th.
				35-45 internodal joints . . . . .	
	Rays may divide three times. The second free brachial a syzygy. Pinnule on first brachial.			5-7 internodal joints. Nodal joints not enlarged, and the hypozygal sharing but little in the cirrus-sockets. Syzygial faces angular.	} <i>blakei</i> n. sp.
				11 or 12 internodal joints. Nodal joints enlarged and projecting, and the hypozygal grooved to receive the cirrus-bases. Syzygial faces nearly plane.	

It will be seen from the preceding table that the Caribbean species of *Pentacrinus* are equally divided between the two groups into which the eight recent species of the genus very naturally fall. Of the remaining types, *P. wyville-thomsoni* and *P. maclearanus* both occur in the Atlantic, the former off the Portuguese coast and the latter off Pernambuco. *P. alternicirra* and *P. naresianus* were dredged by the "Challenger" off the Kermadec Islands, and also to the southeast of the Philippines, the latter species also occurring at another station in the South Pacific.

Most of the *Pentacrinidae* obtained by the "Challenger" in the Pacific represent a new and very curious type, which Sir Wyville Thomson designated by the name of *Metacrinus* in a memorandum on one of his plates. It is readily distinguished from *Pentacrinus* by having, not three, but from four to six radials. The second of these is a syzygial joint, and bears a pinnule, as do all the following joints below the radial axillary. There are numerous other minor differences between *Metacrinus* and *Pentacrinus* which need not be considered here.

The examination of this large series of *Pentacrinidae* fully confirms the views which I have expressed elsewhere \* as to the difficulty of re-

\* Journ. Linn. Soc., Vol. XV. p. 210.

taining the genus *Cainocrinus* Forbes, which has recently been resuscitated by De Lorient.\* The distinguished Swiss paleontologist describes the basals of *Cainocrinus* as in contact with one another all round the calyx, so as to form a complete ring, while those of *Pentacrinus* are small and not contiguous externally, as shown in Miller's figure of *P. caput-meduse* (*asteria* Linn.).† So far as the fossil species are concerned this certainly does appear to be a constant difference, but it is by no means so in the recent ones and in *Metacrinus*. The unique specimen of *P. maclearanus* ‡ has a closed basal ring, and so have all the examples of *P. wyville-thomsoni* that I have seen, though one or more of the basals occasionally fail to meet their fellows. But in *P. naresianus* there appears to be no constancy whatever in this respect. Some individuals of this species have a closed basal ring. But in others the basals are comparatively small and the radials are prolonged slightly downwards over the upper stem-joints. A few exhibit both conditions, some of the basals meeting their fellows, while the rest are separated by the downward projecting radials. The same variation, though in a less degree, occurs in *P. mülleri*. But it is in *P. decorus* that the most remarkable variation occurs in the size of the basals. They are sometimes smaller than those of *P. asteria*, and scarcely more conspicuous than the inter-radial ridges on the stem beneath them; or they may be large triangular knobs standing out prominently from the general plane of the calyx, and meeting one another laterally by their extended lower angles; or they may present any intermediate condition between these two.

The following brief descriptions of the Caribbean species of *Pentacrinus* are not to be considered as complete specific diagnoses. These will appear, together with the synonymy, in my final report.

#### *P. asteria* LINN. sp.

Stem robust, reaching 6 or 7 mm. in diameter, with 13-21 (usually 15-18) internodal joints. Cirrus-sockets widely oval, and occupy nearly the whole height of the nodal joint. The hypozygal joints rarely modified, and then very slightly so.

Cirri reaching 70 mm. in length and composed of 50 stout joints. Lowest limit of the interarticular pores from the ninth to the twelfth node. The two outer radials united by syzygy. The ray-divisions somewhat irregular. Primary arms of 2-6 (distichal) joints; secondary arms of 4-10 (palmar) joints,

\* Monographie des Crinoïdes fossiles de la Suisse, (Geneva, 1877-79,) p. 111.

† A Natural History of the Crinoidea, (Bristol, 1821,) p. 51, Pl. II. fig. 9.

‡ The Atlantic, Vol. II. p. 124, fig. 31.

usually 6-8. Tertiary arms of 6-14 joints, and occasionally another division after 8 or 10 joints more. The first two joints after each axillary united by syzygy, with a pinnule on the epizygal. No other syzygies on the arms.

The joints of the large pinnules on the arm-bases have their distal edge raised into a strongly marked keel, which projects forwards over the base of the next joint. This feature recurs on all the pinnules of the arms, though it is less distinct in their middle and outer portions.

*Remarks.* — The above description is based on the examination which I have made of the following examples of the type: — (a.) Miller's original specimen from Nevis, now in the geological department of the British Museum. (b.) One dry specimen and another in spirit, both in the zoölogical department of the same Museum. (c.) One dry specimen in the Hunterian Collection of the Royal College of Surgeons. (d.) Two dry specimens obtained by Dr. Carpenter and Sir Wyville Thomson from Mr. Damon of Weymouth.

I have not seen either of the individuals described by Gnettard\* (Martinique) and Ellis† (Barbados); but judging from the figures given by these authors I have little doubt that they belong to the type which is now generally known as *P. asteria*. The specimen from Guadeloupe in the Museum of the Geological Society of London, which is mentioned by both Miller and Müller‡ as a *P. caput-medusæ*, is really referable to Oersted's type *P. mülleri*, which is so well described in Lütken's classical memoir.§ If the sixth example mentioned by Müller|| be the one formerly belonging to the Natural History Society at Copenhagen, and bought in 1846 by the University Museum, it is also a *P. mülleri*.

The peculiar features of the pinnules of *P. asteria* afford an excellent specific distinction. They are well shown in Miller's figure,¶ which represents a pinnule some little way out on the arms. In the lowest pinnules the tubercular projection at the distal end of each joint is very marked indeed; and it is recognizable, though of course less distinctly so, all along the arms; so that arm fragments of this species can be readily identified, which is more than can be said for most of the *Pentacrinida*.

The stem also, like the arms, has a definite character of its own, which has not always been correctly described. The nodal joint, i. e. that which is pierced by the canals lodging the cirrus-vessels, is united by syzygy to the joint below it, just as in *P. mülleri* and in all the *Pentacrinida*; but this lower or hypozygal joint is not grooved externally for the reception of the thick basal

\* Mém. de l'Acad. Roy. des Sci. Paris, 1755 (published 1761), pp. 228-247, Pl. VIII., IX.

† Phil. Trans., 1762, Vol. LII. Part I. pp. 357-362, Tab. XIII.

‡ Abhandl. d. Berlin. Akad., 1843, p. 185.

§ Om Vestindiens Pentaeriner, med nogle Bemaerkninger om Pentaeriner og Søliher i Almindelighed. Videnskab. Meddel. fra den naturhist. Foren. i Kjøbenhavn, 1864, Nr. 13-16, pp. 195-245, Tab. IV., V.

|| *Loc. cit.*

¶ *Loc. cit.*, p. 51, Pl. II. fig. 5.

portions of the cirri, as is markedly the case in *P. decorus*, and less so in *P. mülleri* and in most species of the genus. It has therefore often been said that the nodal joints of *P. asteria* are simple and low, while those of *P. mülleri* are double and thick. This is not strictly true. The nodal joints are always single and united by syzygy to those next below them, though the line of junction is frequently almost obliterated. The hypozygals may be modified to receive the cirrus-bases, as in *P. mülleri* and *P. decorus*, or they may not differ in external appearance from the other internodal joints, as in *P. asteria* and *P. wyville-thomsoni*. In this last species, however, the joint above the node is slightly excavated to receive the wide basal portions of the cirri, and this character is still more marked in the genus *Metacrinus*.

### *P. mülleri* OERST.

Stem generally robust, reaching 6 mm. in diameter, with 4-10 (usually 6-9) internodal joints. The cirrus-sockets, which do not reach the upper edges of the nodal joints, are variable in shape. Some are oval, and encroach but little on the hypozygal, while others are more circular and extend well down on to it.

Cirri reaching 50 mm. in length and composed of about 40 stout joints.

Lowest limit of the interarticular pores from the fourth to the eighth node.

The two outer radials united by syzygy. There are usually 6 or 8 arms on each ray in the following order, 2, 1; 1, 2, or 2, 1, 1; 1, 1, 2, the axillaries being limited to the outer arm of each successive pair. Primary arms of 2 (distichal) joints, which are united by syzygy. Secondary arms of 2-7 (palmar) joints, usually 3. The two following divisions are usually of 3 joints each, but may have 5 or 6. The first two joints after the palmar and subsequent axillaries are united by syzygy with a pinnule on the epizygal. No other syzygies on the arms.

The lower joints of the pinnules are somewhat prismatic, and the following ones laterally compressed, with sharp dorsal edges.

Examples of this type were dredged by the "Blake" at the following stations\*: —

1877-78. Off Havana. 175 fathoms.

1878-79. No. 193. Off Martinique. 169 fathoms.

No. 291. Off Barbados. 200 fathoms.

*Remarks.*—A dry example of this species was obtained by Sir Wyville Thomson from Mr. Damon, and a spirit one was brought home from Barbados by Sir Rawson Rawson. Its stem is readily distinguished from that of *P. asteria* by the shortness of the internodes and the modification of the hypozygal joints, which, however, is far less marked than in *P. decorus*. The basals generally

\* The complete list of localities for the different Crinoids dredged by the "Blake" will doubtless be drawn up by Mr. Agassiz and his assistants. I cannot, of course, do more than record the localities of the selected specimens which have been sent to Europe for study.

form a complete ring ; while the branching of the arms is much more regular than in *P. asteria*, and there are fewer joints between the successive axillaries.

### *P. decorus* WYV. THOMSON.

Stem slender, rarely exceeding 4 mm. in diameter, with 7-16 (usually 11 or 12) internodal joints. The nodal joints are generally somewhat enlarged, with circular cirrus-sockets which do not nearly reach their upper edge, but extend well down on to the hypozygal joints.

Slender cirri composed of 25-35 joints, and reaching 28 mm. in length.

Lowest limit of the interarticular pores from the ninth to the eleventh node.

The two outer radials united by a ligamentous articulation. Ray-divisions rather irregular. Primary arms of 2-7 (distichal) joints, of which the first two are united by a ligamentous articulation, the second bearing a pinnule, while the last two often form a syzygy. Secondary arms of 1-9 (palmar) joints, which are very variable in their character. The second free brachial is usually a syzygial joint. The next syzygy from the eighth to the thirtieth brachial, after which an interval of 5-11 joints between successive syzygies.

A pinnule on the first joint after the last axillary. Pinnule joints laterally compressed, those at the base of the lower pinnules being rather broad, but the following ones are elongated.

Examples of this type were dredged by the "Blake" at the following stations :—

1877-78. Off Havana. 175 and 177 fathoms; very abundant.

1878-79. Nos. 155 and 156. Off Montserrat. 88 fathoms.

No. 269. Off St. Vincent. 124 fathoms.

*Remarks.*—The distinctness of this species from *P. asteria* was first recognized by Mr. Damon of Weymouth, who procured an example of it from the seas of the outer Antilles. Its occurrence was recorded by the late Sir Wyville Thomson in a popular article on "Sea Lilies," which was published in the "Intellectual Observer" for August, 1864, but no formal description of it has since appeared. At that time Sir Wyville seems to have been unacquainted with the description of *P. mülleri* by Oersted, published six years previously, for he spoke of *P. asteria* and *P. decorus* as "the only two known living species" of Stalked Crinoids. But in the following year\* he referred to *P. mülleri* as well, Lütken's memoir having appeared in the interval ; so that he evidently regarded *P. decorus* and *P. mülleri* as separate species. Later on (1872), however, he seems to have come to the conclusion that his *P. decorus* was identical with Oersted's species. For, having previously said that *P. asteria* and *P. decorus* were the only two known living species of the genus, he made nearly the same statement † concerning *P. asteria* and *P. mülleri*. He likewise repeated most

\* Phil. Trans., Vol. CLV. p. 542.

† On the Crinoids of the "Porcupine" Deep-Sea Dredging Expedition, Proc. Roy. Soc. Edinb., Vol. VII. pp. 765-767 ; and "The Depths of the Sea," pp. 434-442. See also "The Atlantic," Vol. II. p. 126.

of his original description of *P. decorus* as a diagnosis of *P. mülleri*, with a reference under the latter name to the specimen which he had before him when describing *P. decorus*. He stated that the two outer radials of *P. asteria* are united by syzygy, and further added that "the arrangement of the joints and the syzygies in the cup is the same in *P. mülleri* as in *P. asteria*, only the syzygy between the second radial and the radial axillary is not so complete." This description obviously refers to a ligamentous articulation as distinguished from a true syzygy on the one hand, and from a muscular joint on the other; and it is by no means in accordance with Lütken's very positive statements\* as to the presence of a syzygy between the two outer radials of *P. mülleri*. Neither does Sir Wyville's description of the nodes as occurring about every twelfth joint agree with Lütken's diagnosis, which only records 4-10 internodal joints in *P. mülleri*. As a matter of fact there are 11 or 12 internodal joints in *P. decorus*, and there is no syzygy at all between the two outer radials, but only a ligamentous articulation such as occurs in the majority of the *Neocrinoidea*, and has often been wrongly spoken of as a syzygy, though clearly distinguished from it by Müller.

Had Sir Wyville lived to work out the "Blake" collection more fully than he was able to do before his health gave way, I cannot but think that he would have returned to his original views as to the distinctness of his *P. decorus* from Oersted's *P. mülleri*. The two species have really no sort of resemblance to one another, differing in all the characters of the stem, the cirri, the calyx, and the arms.

Curiously enough, *P. decorus* appears to be the most common species of the genus in the Caribbean Sea. One of the "Blake" specimens is remarkable for the total absence of cirri along the whole of one face of the stem; while at one of the nodes two more cirri are missing, so that there are only two present instead of the usual five.

#### *P. blakei* n. sp.

Stem slender, not reaching 4 mm. in diameter with 5-7 internodal joints. Nodal joints not enlarged. The small circular cirrus-sockets do not nearly reach their upper edges, and extend but slightly downwards on to the hypozygals.

Slender cirri composed of 25 joints and barely 20 mm. long.

Lowest limit of the interarticular pores from the sixth to the tenth node.

The two outer radials united by a ligamentous articulation. Usually only 4 arms on each ray. Primary divisions of 1-4 (distichal) joints, of which the first two are united by a ligamentous articulation. If 4 distichals are present, the second bears a pinnule and the two outer ones form a syzygy. The first free brachial bears a pinnule, and the second is usually a syzygial joint, while other syzygies occur on the arms at very irregular intervals. The proximal face



of the epizygal forms a sharp angle which projects backwards into the retreating distal face of the hypozygal.

Examples of this species were dredged by the "Blake" at the following stations:—

1878-79. No. 157. Off Montserrat. 120 fathoms.

No. 281. Off Barbados. 200 fathoms.

*Remarks.*—This species is at once distinguished from *P. decorus* by the shortness of the internodes of the stem and the absence of any enlargement at the nodes. The calyx is closely similar to that of the variety of *P. decorus* with small basals, but the arm-bases have a totally different appearance from those of that type, owing to the peculiar nature of the syzygy in the second brachials and in the subsequent syzygial joints. The two apposed faces are not plane as is usually the case, but the hypozygal has its distal face sharply incised, while the proximal face of the epizygal is in two planes, which make a sharp angle with one another and project backwards into the hypozygal. This peculiarity is best seen in a side view of the arm, unless the joints are separated by boiling with potash or soda. The only other species of *Pentacrinus* in which it occurs is the ten-armed *P. neresianus* from the Western Pacific. In both cases it may be traced in all the syzygies of the arms, so that small fragments of them are easily recognizable.

Both the recent species of *Rhizocrinus* occur in the Caribbean Sea. *R. lofotensis* was dredged in the Florida Straits by the late Mr. Pourtalès, a few months before the publication of M. Sars's well-known description of it; and *R. rawsoni*, first found by the "Hassler" off Barbados, was subsequently obtained by the "Blake" in 1877-78 and 1878-79.

So far as my information goes, the distribution of these two species is as follows:—

#### *R. lofotensis.*

Bibb. 1868. Off the Samboes. 237 fathoms.

Off Sand Key. 248 and 306 fathoms.

1869. Off Cojima near Havana. 450 fathoms; and several times at lesser depths.

Blake. 1877-78. No. 29. Lat.  $24^{\circ} 36' N.$ , Long.  $84^{\circ} 5' W.$  955 fathoms.

No. 43. Lat.  $24^{\circ} 8' N.$ , Long.  $82^{\circ} 51' W.$  339 fathoms.

No. 44. Lat.  $25^{\circ} 33' N.$ , Long.  $84^{\circ} 35' W.$  539 fathoms.

No. 56. Off Havana. Lat.  $22^{\circ} 9' N.$ , Long.  $82^{\circ} 21' 30'' W.$   
175 fathoms.

#### *R. rawsoni.*

Hassler. 1872. Off Sandy Bay, Barbados. 100 fathoms.

Blake. 1877-78. No. 32. Lat.  $23^{\circ} 32' N.$ , Long.  $88^{\circ} 5' W.$  95 fathoms.

Off Havana. 175 fathoms.

Mr. Agassiz mentions in his dredging letters that he obtained a number of specimens of *Rhizocrinus* among the Windward Islands in 1878-79, and a few specimens in 1880 on the line from Cape Hatteras to St. George's Shoal; but not having seen any of them, I can say nothing as to the species which they represent.

In 1869 two examples of this genus were obtained by the "Porcupine" off Cape Clear, in 862 fathoms (No. 42), and were referred at the time to *R. lofotensis*. On comparing them, however, with some specimens of *R. rawsoni* from off Havana, I find that they really belong to this type, as I had always suspected since reading Pourtalès's description of it.\* *R. rawsoni* was also dredged by the "Challenger" in 900 fathoms among the Azores. It is readily distinguished from *R. lofotensis* by its more robust appearance and elongated calyx, which is nearly always constricted at the basiradial suture, instead of widening gradually upwards, as does that of *R. lofotensis*. The first radials are much shorter relatively to their width than in *R. lofotensis*, and the epizygial of the syzygial first brachial is not markedly narrower than the hypozygial as in the latter species. The greater part of the cup is formed by the elongated basals. In the Norwegian variety of *R. lofotensis* these fuse so very completely that no sutures are usually visible on the exterior of the calyx. This led Sars † and Ludwig ‡ to suggest that the basals of the young *Rhizocrinus* undergo metamorphosis into a "rosette," as in most *Comatulæ*, though this view is not supported by the observations of Pourtalès § and myself; || and the fact that the so-called "enlarged upper stem-joint" of *R. lofotensis* really consists of the anchylosed basals as originally stated by Mr. Pourtalès ¶ for the Caribbean variety is now generally recognized.\*\* The difference in the relative proportions of the two species is seen in the following table, which also shows the sizes of the stem-joints in the examples of *R. rawsoni* that were dredged by the "Blake," "Challenger," and "Porcupine" respectively, and in Sars's largest specimens of *R. lofotensis*.

\* Zoological Results of the "Hassler" Expedition, Ill. Cat. Mus. Comp. Zoöl., No. VIII. pp. 27-31.

† Mémoires pour servir à la Connaissance des Crinoïdes Vivants, p. 12.

‡ Morphologische Studien an Echinodermen, Band I. pp. 120-122.

§ *Loc. cit.*, p. 29.

|| On some Points in the Anatomy of *Pentacrinus* and *Rhizocrinus*. Journ. Anat. and Phys., Vol. XII. pp. 48-53.

¶ Contributions to the Fauna of the Gulf Stream at great Depths. Bull. Mus. Comp. Zoöl., Vol. I. No. 7, pp. 128-130.

\*\* Zittel's Handbuch der Palaeontologie. Palaeozoologie, Band I. p. 393.

Expedition.	Depth.	Base.		Length of Stem.	No.	Stem-Joints.	
		Height.	Width.			Length.	Width.
	fath.	mm.	mm.	mm.		mm.	mm.
Blake	175	5.5	2.50	150	68	3.50	2.25
Challenger	900	5.0	2.00	150	53	3.00	2.00
Porcupine	862	3.0	1.75	50	30	2.25	1.25
G. O. Sars	300	2.0	1.50	70	67	1.50	0.50
<i>R. lofotensis</i> (maximum.)							

N. B. — Pourtalès described his largest specimen of *R. lofotensis* as having a stem nearly 130 mm. long and composed of 59 joints, the length of which averages three times their diameter.

The stem-joints of *R. rawsoni* are relatively shorter and thicker than those of *R. lofotensis*, in which the length is three times the width. In absolute size, as well as in the proportions of the basals and of the stem-points, the "Porcupine" examples of this type are the ones which approach *R. lofotensis* most nearly. They are smaller than those from the Azores, which are themselves smaller than the Caribbean specimens, a fact which is doubtless due to variations of temperature. The difference in size between the largest specimens of *R. lofotensis* found by Sars and Pourtalès respectively is likewise probably the result of the difference between the temperature of the Gulf Stream in the Florida Straits and that of the Northeast Atlantic. It is noteworthy that an elongated calyx resembling that of *R. rawsoni* is chiefly found in those individuals of *R. lofotensis* which have the arms best developed; \* so that this species probably represents a further stage in the degradation of the Apioerinite type than is reached by *R. rawsoni*. The occurrence of the latter form in the Eastern Atlantic is of extreme interest, owing to its remarkable resemblance to *Bourgueticrinus londinensis*. This type was named by Forbes from some isolated stem-joints in the London clay; but a well-preserved calyx has since been discovered, which is now preserved in the Natural History Museum at South Kensington.

Several species closely allied to *B. londinensis*, which occur in the Tertiary deposits of France and Italy, are referred by Zittel † and other palæontologists to the genus *Conocrinus* D'Orbigny; e. g. *C. pyriformis* Münster. sp., *C. thorenti* D'Arch. sp., *C. cornutus* Schaffh. sp., *C. suessi*

\* Sars, Crinoïdes Vivants, p. 4.

† Palæontologie, p. 392. See also Meneghini, "I Crinoïdi Terziarii," Atti d. Soc. Tosc., Vol. II. pp. 11-17. Schluter, "Ueber einige Astylide Crinorden," Zeitsch. d. deutsch. geol. Gesellsch., 1878, pp. 52-55. De Loriol, "Crinoïdes fossiles de la Suisse," p. 190; and Palæontologie Française, "Terrain Jurassique," Tom. XI. (1882), p. 65.

Munier-Chalmas sp., and *C. sequenzai* Menegh. That they are congeneric with Forbes's species and with *Rhizocrinus* I have not the smallest doubt; and the question therefore arises whether *Conocrinus* D'Orbigny is to take precedence over *Rhizocrinus* Sars.

On this subject Prof. Zittel remarks, "Nach den Regeln der Priorität gebührt dem Namen *Conocrinus* D'Orb. die Priorität, wenn gleich die Gattungsdiagnose D'Orbigny's unvollständig und theilweise unrichtig ist."

The type on which D'Orbigny founded *Conocrinus* was the *Bourgueticrinus thorenti* of D'Archiac, but his definition of it was so incomplete and so incorrect that, even supposing Sars had not defined *Rhizocrinus* as elaborately as he did, I should not admit *Conocrinus* as a valid genus until it had been re-defined. Lütken\* remarked, in 1864, that its distinctness from *Bourgueticrinus* was still a matter of uncertainty. D'Orbigny† spoke of it as "Genre voisin des *Bourgueticrinus*, mais sans pièces basales comme les *Eugenicrinus*"; and again, "C'est un *Bourgueticrinus* ayant la tige comprimée, mais avec une seule série de pièces basales." If he considered it as near *Bourgueticrinus* and as resembling *Eugenicrinus*, why did he omit it altogether from the tabular scheme of the *Apiocrinidæ*, which appears on page 2 of his "Histoire Naturelle des Crinoïdes Vivans et Fossiles," and contains the names of both those genera? It would seem from his reference to the absence of any tertiary species of *Bourgueticrinus* on page 96 that he included them all in *Conocrinus*, which would belong to a different family altogether. This shows how he had misunderstood its real character and affinities, and as a matter of fact his description of it as having no basals is entirely incorrect. They are visible enough in D'Archiac's figures of *B. thorenti* (the type-species of *Conocrinus*), and in other closely allied species. Lastly, the remark that *Conocrinus* is a *Bourgueticrinus* with a compressed stem, is worthless as a generic description, when the latter genus itself is described as having a round or compressed stem.

The differences between the two types are of an entirely different character from those mentioned by D'Orbigny, which would be absolutely unintelligible in the absence of figures or of original specimens. I feel it only right, therefore, to ignore *Conocrinus* altogether, and to adopt Sars's well-known genus *Rhizocrinus*.

The differences between *Apiocrinus* and *Millericrinus* on the one hand, and *Bourgueticrinus* and *Rhizocrinus* on the other, have led Mons. de

\* *Loc. cit.*, p. 212.

† *Prodrome de Paléontologie Stratigraphique Universelle*, 1850, Tom. II, p. 332.

Loriol\* to establish a new family *Bourgueticrinida*, which comprises the two genera just mentioned, together with *Bathycrinus* and *Mesocrinus*, a genus recently proposed by myself. De Loriol also includes in it *Ilycrinus* of Danielssen and Koren; but this genus is certainly identical with *Bathycrinus*, which was founded by Sir Wyville Thomson † on an immature specimen dredged by the "Porcupine" in 2435 fathoms, two hundred miles south of Cape Clear. His description ‡ of the larger species, *B. aldrichianus*, from the Southern Sea, seems not to have reached the Norwegian naturalists before the publication of their genus *Ilycrinus*, which was founded on much more developed individuals than that dredged by the "Porcupine."

Of the four genera included in De Loriol's new family, *Bourgueticrinus* and *Rhizocrinus* are the two most closely allied. The differences between them are greater than was supposed by Sars, owing to his mistake about the basals of the latter type, and may be summarized as follows:—

*Bourgueticrinus*. Lower stem-joints not longer than wide; while one or two at the top of the stem are much longer than those below, and help to form the "summit." Basals usually wider than high.

*Rhizocrinus*. Lower stem-joints usually much elongated, two or three times as long as wide. Those just below the calyx are the shortest, often being mere disks. Basals usually much longer than wide, occupying the greater part of the length of the calyx, which expands somewhat from below upwards.

The last type to be mentioned is the remarkable genus *Holopus*, about which much information will be found in a communication§ by Sir Wyville Thomson to the Royal Society of Edinburgh, in 1877. Since the publication of this paper Sir Wyville made a horizontal section of the cup about two thirds of its height from the base. I was never fortunate enough to learn his own views on the subject, but the appearance of the section leads me to believe that the lower part of the cup is formed by basal plates which project inwards and upwards above the level of the outer edges of the radials, just as in *Pentacrinus*.||

\* Paléont. Franç., *loc. cit.*, p. 63.

† The Depths of the Sea, pp. 450-454, fig. 73; and Proc. Roy. Soc. Edinb., Vol. VII. pp. 772, 773.

‡ "Notice of new Living Crinoids belonging to the Apiocrinida," Journ. Linn. Soc. Zoölogy, Vol. XIII. pp. 48-51.

§ "On the Structure and Relations of the Genus *Holopus*," Proc. Roy. Soc. Edinb., Vol. IX. p. 409.

|| Schlüter (*loc. cit.*, p. 51) is inclined to believe that basals are present in *Cyathidium spileccense*. Like Sir Wyville Thomson, I am unable to differentiate *Cyathidium* from *Holopus*.

Sir Wyville left it an open question whether the articular facets on the upper edge of the calyx-tube belong to the first or to the second radials. I believe myself that they are of the former nature, partly on account of their great resemblance to those of certain fossil species, and partly because the axillaries appear to me to be syzygial or double joints.

Sir Wyville has pointed out that the cup exhibits a very marked division into bivium and trivium; for "one side of the border is much thicker and considerably higher than the other side, and the three arms articulated to it are much larger than those articulated to the opposite side." In fact, the three facets of the trivium are themselves unequal, the centre one being both longer and wider than the other two, which are themselves longer and a little wider than the two facets of the bivium. This want of symmetry in the calyx is very remarkable, as it is precisely similar to that described by De Loriol\* in *Eugeniocrinus mayalis*, from the *Leptæna* bed (Middle to Upper Lias) of Calvados in Normandy. The calyx of this species, formed by the five contiguous radials, tapers away downwards to a truncated extremity, which De Loriol supposes to have rested on the top stem-joint, basals being apparently absent.

But although *Eugeniocrinus mayalis* probably had a short stem, it is certainly very closely allied to *Holopus*. The calyx as well as the second and third radials are covered with scattered granules of variable size, just as in *Holopus*. The two outer radials were united by a muscular joint; but in a closely allied species, *E. deslongchampsii*, which is more symmetrical and less coarsely granular than *E. mayalis*, they are united by syzygy, just as I believe to be the case in *Holopus*. Together with the calyces and separate radials of these two species, the *Leptæna* bed contains a large number of isolated arm joints,† some of which are extraordinarily like those forming the lower part of a *Holopus* arm.

One reason why I suspect the axillaries of *Holopus* to be syzygial joints is as follows. In one individual the axillaries on the two rays of the bivium are distinctly in two parts, though the sutural lines do not extend right across them. On the three axillaries of the trivium, however, no sutural lines are visible at all; though they are just traceable in another specimen, and are fairly distinct in a young one 8 mm. high.

The condition of the very young individual which was obtained by the "Blake" at Station 22, and was figured in Volume V. No. 9 of the

\* Palæontologie Française. Terrain Jurassique, Tom. XI. p. 78, Pl. VIII. figs. 1-5.

† *Loc. cit.*, Pl. XI.

"Bulletins," seems to point to the same conclusion ; for the lower ring of pentagonal (or rather hexagonal) plates must surely be the second radials, and the triangular ones above them the axillaries.

A fragment of a living *Holopus* was dredged by the "Blake" in 120 fathoms, off Montserrat (No. 157). It was preserved in spirit and sent over to Sir Wyville Thomson, who asked me to cut some sections of the arms for him. The condition of the dried individuals hitherto known had led him to suspect "that the tissues are very imperfectly differentiated, almost protoplasmic. When an arm is put into boiling water it falls to pieces at once, the joints simply coming asunder, and showing no trace of muscular or other organic connection except the axial cords of the joints, which sometimes keep two joints hanging in connection for a little." The spirit specimen, however, told a different tale altogether, and the sections which I have made from it show that the soft parts of *Holopus* differ but little from those of any ordinary Crinoid. The arm-joints are articulated by means of muscles and ligaments in the usual way. The two large arm-canals, the cœliac and the subtentacular, are separated by a smaller genital canal containing the genital cord. This has exactly the same structure as that of any common *Antedon*, and the ovaries which it bears at intervals are much more like those of *Antedon eschrichti* in their histological structure than are those of many *Comatule*. The ambulacral groove is quite narrow in proportion to the breadth of the arm, and the ovaries extend but a very little way into the pinnules. The branches which leave the axial cords of the arms to supply the pinnules take a somewhat singular course. For they are thrown into loops in a dorsoventral direction, which are small at first, immediately beneath the arm-canals, but become much more marked at the bases of the pinnules, within which the cords still retain an undulating course.

Above the water-vessel is the usual darkly colored ambulacral epithelium, which is doubtless separated from the water-vessel by the ambulacral nerve and bloodvessel, though I have not been able to see them clearly. There are no large and imbricated reniform plates at the sides of the ambulacra, such as occur in *Rhizocrinus*, *Bathycrinus*, and *Hyo-crinus*. But the tentacles are unusually large, and taper rapidly from a broad base ; while the lower thick part of the shaft of each tentacle is protected by a well-developed calcareous reticulation, above which are groups of more or less closely united spicales.

*List of Additional Stations of Stalked Crinoids collected by the  
"Blake." Prepared by J. WALTER FEWKES.*

**RHIZOCRINUS.**

**R. lofotensis SARRS.**

* Blake, 1877-78.	No. 35.	Lat. 23° 54' 46" N. †	Long. 88° 58' W.	804 fath.
"	1878-79.	No. 238.	Off Grenadines . . . . .	127 "
"	"	No. 248.	Grenada . . . . .	161 "
"	"	No. 259.	Grenada . . . . .	159 "
"	"	No. 274.	Barbados . . . . .	209 "
"	1880.	No. 306.	Lat. 41° 32' 50" N. Long. 65° 55' W.	524 "
† U. S. Fish Com.	1882.	No. 1124.	S. S. E. Off Nantucket . .	640 "

**R. rawsoni POURTALÈS.**

Blake, 1878-79.	No. 155.	Montserrat . . . . .	88 fathoms.
"	"	No. 166.	Guadeloupe . . . . . 150 "
"	"	No. 177.	Dominica . . . . . 118 "
"	"	No. 211.	Martinique . . . . . 357 "
"	"	No. 273.	Barbados . . . . . 103 "
"	"	No. 277.	Barbados . . . . . 106 "
"	"	No. 290.	Barbados . . . . . 73 "
"	"	No. 296.	Barbados . . . . . 84 "
"	"	No. 297.	Barbados . . . . . 123 "
Capt. E. Cole.		Saba Bank . . . . .	200 "

**PENTACRINUS.**

**P. asteria LINN.**

* Blake, 1878-79.	No. 157.	Montserrat . . . . .	120 fathoms.
Dr. Schramm.		Guadeloupe . . . . .	Depth ?

\* The identifications on labels in bottle with specimens, marked in this list with an asterisk, are in Mr. Pourtalès's handwriting.

† In list of Stations, Bull. Mus. Comp. Zool., VI. 1, p. 9, Lat. reads 23° 52'.

‡ Verrill, American Journal, November, 1882.



**P. mülleri** OERSTED.

Blake, 1878-79.	No. 100.	Off Morro Light . . . . .	250-400 fathoms.
"	"	No. 101. Off Morro Light . . . . .	175-200 "
"	"	No. 157. Montserrat . . . . .	120 "
"	"	No. 171. Guadeloupe . . . . .	183 "
"	"	No. 218. St. Lucia . . . . .	164 "
"	"	No. 269. St. Vincent . . . . .	124 "
* "	"	No. 274. Barbados . . . . .	209 "
"	"	No. 280. St. Charles Lighthouse (Barbados)	221 "
"	"	No. 283. Barbados . . . . .	237 "
"	"	No. 295. Barbados . . . . .	180 "
"	"	No. 296. Barbados . . . . .	84 "
"	"	V. Santiago de Cuba (Bartlett) . . . . .	288 "

**P. decorus** WYVILLE THOMSON.

Blake, 1877-78.	No. 21.	Bahia Honda (Cuba) . . . . .	287 fathoms.
W. Stimpson.		Cuba.	
Blake, 1877-78.		Off Havana (Sigsbee) . . . . .	150-200 "
"	"	No. 56 or 57. Lat. 22° 9' 15" N., Long. 82° 21' W.	
		(Sigsbee) . . . . .	175 "
"	1878-79.	No. 100. Off Morro Light . . . . .	250-400 "
Capt. E. Cole.		S. side of Porto Rico . . . . .	667 "
Blake, 1878-79.	No. 101.	Off Morro Light, Havana . . . . .	175-250 "
"	"	No. 156. Plymouth, Montserrat . . . . .	88 "
"	"	No. 157. Montserrat . . . . .	120 "
"	"	No. 233. Milligan's Key, St. Vincent . . . . .	174 "
"	"	No. 296. Barbados . . . . .	84 "
"	"	No. 298. Barbados . . . . .	120 "
Gov. Rawson (ident. by Mr.		Pourtales as <i>P. mülleri</i> ). Barbados.	Depth ?
Blake, 1880.		Kingston (Bartlett) . . . . .	100 fathoms.

**P. blakei** P. H. CARPENTER.

Blake, 1878-79.	No. 209.	Martinique . . . . .	189 fathoms.
"	"	No. 295. Barbados . . . . .	180 "